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(54) **Rail-mounted stabilizer for surgical instrument**

An einer Bettschiene anbringbare Stabilisiervorrichtung für chirurgische Instrumente

Stabilisateur monté sur rail de lit d'hôpital pour supporter un instrument chirurgical

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Description

[0001] This invention relates generally to universal positioning devices, and in particular to apparatus mountable on the side rail of an operating table for selectively positioning and stabilizing a surgical instrument during a surgical procedure.

[0002] In the performance of surgery and related procedures, it is sometimes necessary to support and stabilize a surgical instrument such as an endoscope or retractor in an elevated position above an operating table for long periods of time, with a probe portion of the instrument being held steady within a body cavity. An endoscope is a slender viewing tube which may be rigid or flexible, and includes an optical lens system and a light source. Endoscopes are used to provide visual access within a body cavity, for example, the abdominal cavity, the knee, shoulder, bladder, uterus or bowel. A laparoscope is a type of endoscope which includes a rigid viewing tube for insertion through the abdominal wall.

[0003] It is necessary to vary the position of the instrument from time-to-time according to the needs of the surgical procedure. During a laparoscopic cholecystectomy (gall bladder removal), for example, an endoscope is inserted into the upper abdominal cavity which is pressurized with carbon dioxide by an insufflating machine. The endoscope is guided through a trocar sheath which serves as an interface port through the abdominal wall. By sliding the endoscope up and down the port, or rotating the endoscope in a desired direction, a view of the internal organs is presented to a video camera which is attached to the endoscope, with the image being displayed on a remote video monitor.

[0004] The video camera also monitors the movement of other surgical instruments, for example, a grasper, a hook, a spatula, forceps and dissector, which are guided into and out of the abdominal cavity through one or more secondary surgical trocar sheaths. When the distal tip of the instrument appears on the video monitor, the surgeon guides it into place and controls its action and movement as it is displayed on the video monitor. It is usually necessary to re-position the endoscope from time-to-time to view the operative site so that the surgical instruments are positioned appropriately within the cavity relative to the organ or internal tissue for inspection, repair, dissection or excision.

[0005] The success of such procedures depends in part on the surgeon's ability to judge spatial relationships as viewed on the video monitor, and to quickly adjust or reposition the surgical instrument as the procedure progresses. During gall bladder removal, for example, it may be necessary to re-position the endoscope and hold it in a desired orientation as the gall bladder duct is sealed by a surgical clip. Additionally, it may be necessary to re-position the endoscope while using an electrocautery instrument to excise the gall bladder from the underside of the liver. After the gall bladder organ has been severed, it is removed through an exit port. It is then necessary to re-position the endoscope to an upper midline port so that the surgeon can correctly position and operate a grasper instrument through a secondary trocar port.

[0006] Once the precise anatomy-viewing position is established, it must be securely maintained. Otherwise, the physician's view will be interrupted, with loss of visual contact at a critical moment during the operation, which prolongs the procedure. Moreover, due to slippage, the endoscope instrument can exert pressure on tissues and soft organs.

[0007] In some cases, operating room personnel manually hold the surgical instrument in a desired position and move it about according to the surgeon's instructions. The use of operating room personnel to support such instruments during an extended surgical procedure is unsatisfactory in that the assistant may not be able to maintain stability because of muscle fatigue, and find it necessary to change position at some critical or otherwise inconvenient time.

[0008] Operating tables are provided with narrow side rails on which surgical support equipment may be attached. However, because the side rails are located near the sterile operating field, certain instrument support positions are difficult to achieve. Generally, it is desirable to support surgical instruments above the operating table and laterally offset with respect to the side rails to allow a wide range of support positions across the sterile field.

[0009] Moreover, some conventional rail-mounted positioning equipment must be manually released from time-to-time to re-position instruments which are suspended above the sterile field. It will be appreciated that in surgical procedures, time is of the essence and delays associated with adjustment of support equipment prolong the procedure. Additionally, the presence of surgical support equipment within the sterile operating field limits the surgeon's access to the patient during the procedure. Consequently, it is generally desirable to limit the number of surgical support devices in and about the sterile field so that the operating surgeon and his attendants will have clear and unrestricted access to the patient, and will also have a clear and unrestricted view of patient monitoring equipment.

[0010] During certain procedures, it may be desirable to impose or change a biasing force on a retractor or other surgical instrument to stabilize its position within the surgical cavity. It is desirable to support such equipment both laterally and vertically in the regions immediately surrounding the sterile field of the operating table so that the appropriate bias forces may be applied, without restricting the surgeon's access to the patient.

[0011] EP 0 595 291 discloses a surgical instrument support apparatus substantially as defined in the preamble to Claim 1 of the present application.

[0012] EP 0 239 409 discloses a robot for surgical operation which comprises an arm means mounted at its

one end on a vertical support means and extended in a predetermined direction. The robot comprises a drive means mounted on the other end of the arm and adapted to extend substantially horizontally further in said predetermined direction. A head or trepan is mounted at the extended end of the drive by said drive means. Light transmissive fibre or the like is mounted on the trepan and takes an image of the patient and a controller process is provided through which video data processing provides control for the position and tilt of the trepan with respect to the patient.

[0013] EP 0 587 948 discloses an endoscopic stabiliser including a universal positioning arm assembly for holding a surgical instrument such as an endoscope during surgical procedure. Coarse adjustment of which is provided by a reverse drive motor which extends and retracts the upright support shaft along a vertical axis. Course adjustment of the instrument in the X, Y position with respect to the sterile zone above an operating table is provided by articulated arm sections which are rotatably coupled to the upright support shaft. Fine adjustment of the position is also provided by reverse drive motors.

[0014] WO A 94/03114 discloses a robotic system for holding an endoscope instrument during surgery. It includes a robotic arm assembly and a linear actuator that is fixed to an operating table. The linear actuator is connected to a linkage arm for moving the linkage arm along a vertical (Z) axis. The linear actuator includes an electric motor which turns a worm gear that extends and retracts the support shaft in elevation. The linking sections of the robotic arm are independently movable in angular displacement with respect to each other by motor-driven rotary actuators. The rotary actuators control movement of the robotic arm assembly in the XY plane, while the linear actuator controls movement of the robotic arm assembly in elevation (along the Z-axis).

[0015] Accordingly, there is now provided a surgical instrument support apparatus comprising :

a rail clamp configured for releasable attachment to the side rail of an operating table;

a support arm assembly mounted on the rail clamp, the support arm assembly including a proximal support arm movably coupled to the rail clamp for rotation about a vertical axis and a distal support arm for supporting a surgical instrument in a fixed position overlying the operating table during a surgical procedure;

a clamp attached to the distal support arm for releasably holding a surgical instrument;

position adjustment apparatus coupled to the distal support arm and to the surgical instrument clamp for moving the surgical instrument clamp in elevation relative to the operating table; characterized in that

a first rotary coupling apparatus including a bearing member is coupled to the rail clamp, a rotary coupling shaft is mounted on the bearing member coupled to the proximal support arm, and a brake is releasably coupled to the rotary coupling shaft, the first rotary coupling apparatus being responsive to one or more electrical control signals for selectively engaging the brake and locking the rotary coupling shaft in a first fixed rotational support position and for selectively disengaging the brake and releasing the rotary coupling shaft so that the proximal support arm can be turned from the first fixed rotational support position to a second fixed rotational support position.

[0016] The support assembly of the present invention includes a positioning arm and means for adjusting the elevation and orientation of a surgical instrument within a sterile field above or about a conventional surgical operating table. A manually releasable rail clamp secures the positioning arm on the side rail of an operating table. The positioning arm includes articulated arm sections for holding and stabilizing a surgical instrument, such as an endoscope or retractor, and is movably coupled to an upright support shaft for coarse adjustment of the surgical instrument relative to the operating table. The upright support shaft is rotatably mounted on the rail clamp for varying the X-Y location of the surgical instrument.

[0017] The support assembly preferably includes a releasable brake and a positioning drive motor which are controllable by a foot switch for fine adjustment of surgical instrument position within a body cavity of a patient who is undergoing surgery. The articulated arm has two arm sections which are independently movable with respect to each other to provide a wide range of X-Y rectangular coordinate instrument positions across the sterile field. The articulated arm sections are coupled together by a second rotary coupling member which is lockable and releasable upon application of an electrical control signal from a console switch, or upon application of an electrical control signal from a manual release switch attached to the articulated arm.

[0018] The features and advantages of the present invention will be further appreciated by those skilled in the art upon reading the following detailed description with reference to the drawings, wherein:

FIGURE 1 is a perspective view of the surgical instrument support apparatus of the present invention shown mounted on the side rail of a surgical operating table;

FIGURE 2 is a top plan view of the rail-mounted surgical instrument support apparatus and surgical operating table of FIGURE 1;

FIGURE 3 is a right side elevational view of the rail-mounted support apparatus of FIGURE 1;

FIGURE 4 is a front perspective view of the rail-mounted support apparatus of FIGURE 1 with the surgical operating table removed;

FIGURE 5 is a rear elevational view, partially broken away, of the rail-mounted support apparatus of FIGURE 1;
FIGURE 6 is a sectional view thereof, taken along the lines 6-6 of FIGURE 5;
FIGURE 7 is a side elevational view, partly in section, of an articulated arm assembly;
FIGURE 8 is an elevational view, partly in section, showing a band brake assembly;
FIGURE 9 is a sectional view of a band brake assembly taken along the line 9-9 of FIGURE 8; and,
FIGURE 10 is a simplified control circuit diagram.

[0019] In the description which follows, like parts are indicated throughout the specification and drawings with the same reference numerals, respectively. The drawings are not necessarily to scale, and the proportions of certain parts have been exaggerated to better illustrate certain structural features.

[0020] The surgical instrument support apparatus 10 of the present invention is particularly well suited for use in combination with a conventional surgical operating table 12 during the performance of various surgical procedures, including abdominal, pelvic, joint, bladder, bowel and uterine surgery.

[0021] Referring now to FIGURE 1 and 2, the surgical instrument support apparatus 10 is releasably mounted on the side rail 12 of an operating table 14 for positioning an endoscope 16 during a surgical procedure within the abdominal cavity of a patient P. The support apparatus 10 is anchored to the side rail 12 by a releasable clamp 18, and is located near the head of the operating table to provide standing room for attendants who assist the surgeon S. After the clamp 18 has been locked, the surgical instrument support apparatus 10 is made ready by an attendant.

[0022] The endoscope 16 is supported by an articulated arm assembly 20 which includes a first (proximal) support arm section 20A and a second (distal) support arm section 20B. The articulated arm assembly 20 is supported by an upright support shaft 22. The upright support shaft 22 is rotatably coupled to the rail clamp 18 by a rotary coupling 24 which includes a bearing assembly 58 and a brake assembly 59 (FIGURE 6). The first support arm section 20A is slidably coupled in telescoping relation to the upright support shaft 22 which permits adjustment of the elevation of the support arm 20 relative to the upright support shaft 22. Likewise, the second support arm section 20B is rotatably coupled to the first support arm section 20A by a rotary coupling 26 (FIGURE 3, FIGURE 7). According to this arrangement, the proximal and distal support arm sections 20A, 20B are rotatably coupled together for folding movement relative to each other.

[0023] The angular position of the first support arm section 20A relative to the second support arm section 20B is selectively locked and released by a band brake assembly 28 as shown in FIGURE 7, FIGURE 8 and FIGURE 9. The band brake assembly 28 includes a pair of friction bands 30, 32 fitted about a support shaft 34 and movable from a released, non-engaging position as shown in FIGURE 9 to a locked, braked position (FIGURE 8) in response to retraction of the friction bands 30, 32. The friction bands 30, 32 are selectively retracted by lever arms 36, 38, each mounted for pivotal movement on a pin 40. One end 36A of the lever arm 36 is connected to the free end 32A of the friction band 32, and the opposite end 36B of the lever arm is attached to the plunger 42 of an electrical solenoid K1. The lever arm 36 is biased to the locked, braked position by a coil spring 44.

[0024] According to this arrangement, when the solenoid K1 is energized, the plunger 42 retracts and draws the lever arm end portion 36B in a counterclockwise movement. As this occurs, the bias spring 44 is compressed, thereby releasing the friction band 32 from engagement against the external cylindrical surface of the coupling shaft 34. When operating power is removed from the solenoid K1, the bias spring 44 pushes the lever arm end portion 36B in clockwise movement, thereby drawing the friction bands 30, 32 into engagement with the support shaft 34. When electrical power is removed from the solenoids, the second support arm section 20B is locked relative to the first support arm section 20A.

[0025] The friction band 30 is operated by a second solenoid K2. The plunger of the second solenoid K2 is connected to the lever arm 38 and is mounted for pivotal movement on the pin 40. The solenoids K1, K2 are electrically coupled in parallel to a source of electrical operating power through a position controller 46 as shown in the electrical control circuit diagram of FIGURE 10.

[0026] The band brake assembly 28 is coupled to the bearing assembly 26 by a sleeve member 48 and is coupled to the first support arm section 20A by a tubular housing member 50. The second support arm section 20B is attached to the coupling shaft 34 on its lower end 34A (FIGURE 7). Ball bearing members 52, 54 permit rotation of the coupling shaft 34 relative to the housing member 50.

[0027] Referring now to FIGURE 1, FIGURE 3 and FIGURE 6, the first support arm section 20A is telescopically coupled to the upright support shaft 22 and its elevation relative to the operating table 14 is fixed by a latch pin 56. The first support arm section 20A is intersected by a latch aperture A, and the upright support shaft 22 is intersected by multiple bores 60. The latch apertures A are alignable in registration with each bore 60, so that the latch pin 56 may be inserted through the aligned openings for positioning the first support arm section 20A at a desired elevation with respect to the operating table 14. Preferably, the upright support shaft 22 is integrally formed with the coupling shaft 34. The coupling shaft 34 is rotatably coupled to the rail clamp 18 by the bearing assembly 58.

[0028] Referring now to FIGURE 4 and FIGURE 6, the surgical instrument support apparatus 10 is releasably

attached to the side rail 12 by the rail clamp 18. The rail clamp 18 includes a clamp body 61 which is secured to the external housing of the bearing assembly 58. A pocket or cavity 63 is formed within the clamp body 61 for receiving a compression disk 65. The compression disk 65 is coupled to a screw shaft 67. The screw shaft 67 extends through the clamp body cavity and is rotatable for driving the compression disk 65 to an extended position in which the side rail 12 is clamped between a fixed jaw member 69 and the compression disk. By reversing the rotation of the screw shaft 67, the compression disk 65 is movable to a retracted position allowing release and removal of the fixed jaw member and compression member from the side rail 12. The screw shaft 67 is manually operable by a turn knob 71.

[0029] The bearing assembly 58 has substantially the same construction as the bearing assembly 26, with the lower end 34 of the upright support post 22 being releasably engaged by the brake assembly 59. The brake assembly 59 has the same components and construction as the brake assembly 28, including a pair of friction bands (not illustrated) which are attached to lever arms and solenoids K3, K4 for selectively locking and releasing the angular position of the upright support shaft 24 with respect to the rail clamp 18. The solenoids K3, K4 are electrically wired in parallel with the solenoids K1, K2 for simultaneously receiving electrical operating power from the position controller 46 as shown in FIGURE 10.

[0030] Referring again to FIGURE 3 and FIGURE 10, coarse adjustment of instrument elevation is enabled upon actuation of a brake release switch 62. The brake release switch is a single-pole, non-latching switch which is operable in a momentary ON mode when depressed, and automatically turns OFF when released. Release and lock operation of the solenoids K1, K2, K3 and K4 is enabled by the console-mounted, single-pole, single-throw switch 62. The solenoids are also operable through a floor switch assembly 64 as discussed below.

[0031] After the support assembly 10 has been set up and secured to the side rail 12 as shown in FIGURE 1, an attendant connects the power service cable 66 to an AC power outlet and makes AC power available to the controller 46 by turning the master switch 68 to the ON position. A DC power supply (FIGURE 10) within the controller 46 provides the DC operating current for the drive motor and solenoids. The elevation of the support arm assembly 20 is manually set by the latch pin 56 at an appropriate clearance elevation. The solenoids K1, K2, K3 and K4 are then released by depressing the brake control switch 62. The articulated arm sections 20A, 20B are manually extended over the operating table 14 to place the support arm assembly 20 at an approximate rectangular coordinate (X-Y) grid location over the operating table.

[0032] After the approximate X-Y instrument position has been established, the brake control switch 62 is released and the solenoids are de-energized, thereby locking the extended position of the arms 20A, 20B. A remote video monitor (not shown) is then set up in an appropriate viewing position, and the viewing screen is rotated in alignment with the surgeon's field of view. After the surgical instrument 16 has been attached to the end of the articulated arm, it is covered by a sterile drape 70.

[0033] Referring to FIGURE 7 and FIGURE 10, fine adjustment of instrument elevation above the surgical site along the longitudinal axis C is provided by a DC drive motor 72 having a stator member 72S and a rotor member 72R. The stator member 72S of the DC drive motor 72 is mounted within a drive housing 74. A torque shaft 76, attached to the rotor member 72R, is received in threaded engagement with a coupling collar 78 which is extendable and retractable through the drive housing 74. An extendable support arm 80 is attached to the lower end of the coupling collar 78. Upon clockwise and counterclockwise rotation of the torque shaft 76, the support arm 80 is extended and retracted along the longitudinal axis C.

[0034] Referring again to FIGURE 7, the endoscope instrument 16 is secured to the extendable support arm 80 by a rotatable coupler 82. The coupler 82 is secured for rotation on the distal end of the extendable support arm 80 by a screw clamp 84. The screw clamp 84 includes a threaded shaft 86 and a coupling collar 88. Upon release of the screw clamp 84, the coupling collar 88 can be rotated about the longitudinal axis E of the threaded shaft 86.

[0035] The endoscope instrument 16 is a fiber optic endoscope which has an insertion probe section 16P and a fiber optic video camera 16C. The fiber optic video camera 16C is connected by a signal cable 90 to a remote video recorder unit. A light source 16L is incorporated in the probe section of the endoscope, whereby an image of the internal cavity is provided on a video monitor screen. The probe section 16P of the endoscope is secured by a screw clamp 92. The insertion orientation of the endoscope instrument 16 is adjustable by releasing the screw clamp 84 and rotating the coupling collar 88 until the desired display appears on the viewing screen. According to this arrangement, the surgeon observes the video presentation and makes fine adjustments of the fiber optic camera orientation by selectively actuating the drive motor 72 after the initial insertion orientation has been established.

[0036] According to one embodiment of the invention as shown in FIGURE 10, selective actuation of the reversible drive motor 72 is provided by the pressure responsive foot switch assembly 64. The foot switch assembly 64 includes pressure responsive foot switches 94, 96. A master control release switch 98 is also provided.

[0037] The foot switches 94, 96 are non-latching, momentary ON switches which automatically turn OFF in the absence of foot pressure. The master control release switch 98 is a single-pole, single-throw latching

ON switch which is electrically coupled to an enable circuit within the position controller 46. The enable circuit locks up two control switches 100, 102 (arm up, arm down) which are coupled in parallel with the foot switches 94, 96. Actuation of the master control release switch 98 sets the enable circuit, thereby rendering each foot switch active. A second actuation of the master release switch 98 causes the enable circuit to reset, thereby automatically disabling each of the foot switches 94, 96.

[0038] If fine adjustment of elevation position is desired during the course of a surgical procedure, the operating surgeon S applies momentary foot pressure to the master release switch 98 which enables the foot switches 94, 96. The surgeon S then applies foot pressure to the appropriate switch until the desired video presentation is obtained. After the desired video presentation is obtained, momentary foot pressure is again applied to the master control switch 98 which disables the fine control switches and prevents inadvertent adjustment.

[0039] The foot switches 94, 96 and the master control switch 98 are electrically coupled to the position controller 46 by a multiple conductor cable 104. The position controller 46 applies DC operating voltage of the appropriate polarity to the drive motor 72 in response to actuation of the foot switches 94, 96 or the manual switches 100 (arm up) and 102 (arm down).

[0040] The position controller 46 also applies DC operating voltage of the appropriate polarity to solenoids K1, K2, K3 and K4 in response to actuation of the arm mounted brake release switch 62. Preferably, the internal DC power supply within the position controller 46 produces 12 volts DC which is applied in the appropriate polarity to the drive motor 72 through a two-conductor cable 106. The parallel connected solenoids K1, K2, K3 and K4 are likewise simultaneously energized by 12 volts DC through a two-conductor cable 108 and cable 110. The "Arm Up" switch 100, the "Brake Release" switch 62 and the "Arm Down" switch 102 are coupled to the controller 46 by two-conductor cables 109, 111 and 113, respectively.

[0041] The fine control drive motor 72 is energized with the appropriate operating voltage polarity by the two-conductor cable 106. The manual brake release switch 62, which is attached to the extension arm 80, is coupled to the position controller 46 by the two-conductor cable 111. This switch and wiring arrangement permits an attendant standing on the other side of the operating table to exercise coarse position control of articulated arm elevation during initial setup. It also permits the surgeon S to exercise coarse and fine position control of the articulated arm assembly, and affords hands free, fine control of instrument elevation by applying foot pressure to selected foot switches.

[0042] Referring again to FIGURE 1, FIGURE 3 and FIGURE 6, the surgical instrument support apparatus 10 clamped to the side rail 12 on one side of the operating table, and the foot switch assembly 64 is positioned on the opposite side, adjacent to the operating table support pedestal 112. This orientation of the support apparatus 10 provides access to the surgical site for an attendant, without blocking the surgeon's view across the operating table of a remote video monitor screen.

[0043] The switches 94, 96 and 98, referred to as "pancake" switches, and are sandwiched between two sheets of flexible rubber material. The multiple conductor switch cable 104 is coupled to the position controller 46 by a multiple pin connector which can be connected to and disconnected from the controller 46 as desired.

[0044] Fine positioning control of the endoscope instrument 16 may be accomplished quickly and easily by actuating the appropriate switches on the foot switch assembly 64. The articulated assembly arm 20 can be readjusted as desired by actuating the brake release switch 62. Otherwise, the positioning control may be carried out entirely by foot movements, thereby freeing the surgeon's hands for manipulating other surgical instruments, for example, a grasper, hook, spatula, forceps and dissector, as indicated in FIGURE 1.

[0045] Referring again to FIGURE 7 and FIGURE 8, the surgical instrument clamp 92 is sterile and preferably disposable. The clamp 92 is inserted through a preformed opening in the sterile drape 70. The clamp 92 has a shaft portion 92A which is coupled to the coupling collar 88 by a bayonet/detent coupling. The clamp 92 is freely rotatable about the longitudinal axis E. Additionally, the collar 88 is freely rotatable about the longitudinal axis E of the screw clamp 84. The clamp 92 is adjustable, thereby accommodating a wide range of endoscope sizes/diameters.

[0046] The arm assembly 20 is articulated and can be set up in offset relation on a side rail 12 of the operating table, out of the sterile field. Because of the stable support provided by the rail-mounted support apparatus 10, additional support equipment is not required. The surgical instrument support apparatus 10 may be set up by one person and requires only minimal training. Moreover, additional support personnel are not required for holding or stabilizing the endoscope 16.

[0047] The reach and range of the articulated arm assembly 20 permit the support assembly 10 to be located on the attendant's side of the operating table, thereby providing access to the surgical site on the surgeon's side of the operating table. The sterile drape 70 completely covers the articulated arm assembly and permits the surgeon S to operate freely without contaminating the sterile field. The manual brake release switch 62 is covered by the sterile drape 70 and is actuated by finger pressure applied through the drape.

[0048] Upon completion of a surgical procedure, the endoscope is released, articulated arm assembly 20 is retracted, released and folded inwardly, and the clamp 18 is released from the rail and removed from the table. The surgical instrument support assembly 10 is then ready for storage out of the operating theater, and may

be hand carried from one operating room to another.

Claims

1. Surgical instrument support apparatus (10) comprising:

   a rail clamp (18) configured for releasable attachment to the side rail (12) of an operating table (14);
   a support arm assembly (20) mounted on the rail clamp (18), the support arm assembly including a proximal support arm (20A) movably coupled to the rail clamp for rotation about a vertical axis and a distal support arm (20B) for supporting a surgical instrument (16) in a fixed position overlying the operating table (14) during a surgical procedure;
   a clamp (92) attached to the distal support arm (20B) for releasably holding a surgical instrument (16);
   position adjustment apparatus coupled to the distal support arm (20B) and to the surgical instrument clamp (92) for moving the surgical instrument clamp (92) in elevation relative to the operating table (14); characterized in that
   a first rotary coupling apparatus (24) including a bearing member (58) is coupled to the rail clamp (18), a rotary coupling shaft (34) is mounted on the bearing member (58) and coupled to the proximal support arm (20A), and a brake (59) is releasably coupled to the rotary coupling shaft (34), the first rotary coupling apparatus (24) being responsive to one or more electrical control signals for selectively engaging the brake (59) and locking the rotary coupling shaft (34) in a first fixed rotational support position and for selectively disengaging the brake (59) and releasing the rotary coupling shaft (34) so that the proximal support arm (20A) can be turned from the first fixed rotational support position to a second fixed rotational support position.

2. Surgical instrument support apparatus (10) as claimed in claim 1, wherein the proximal support arm (20A) is adjustably coupled to the rotary coupling shaft (34) for extension and retraction in elevation by means of an upright support shaft (22).

3. Surgical instrument support apparatus (10) as claimed in any preceding claim, wherein the proximal support arm (20A) and the distal support arm (20B) are movably coupled together for angular displacement relative to each other; and

   a second rotary coupling apparatus (26) is coupled between the proximal support arm (20) and the distal support arm (20B), the second rotary coupling apparatus including a brake assembly (28) and being responsive to one or more electrical control signals for selectively locking the proximal support arm (20A) and the distal support arm (20B) in a fixed angular displacement relative to each other and for selectively releasing the brake (28) so that the support arms (20A, 20B) can be angularly displaced relative to each other.

4. Surgical instrument support apparatus (10) as claimed in any preceding claim, wherein the position adjustment apparatus comprises:

   a third rotary coupling apparatus (72,76,78) coupled between the distal support arm (20B) and the surgical instrument clamp (92) for extending and retracting the surgical instrument clamp (92) in elevation relative to the operating table (14).

5. Surgical instrument support apparatus as claimed in claim 4, wherein the third rotary coupling apparatus (72,76,78) comprises:

   a reversible drive motor (72) including a housing member (74) mounted on the distal support arm (20B) and a rotor member (72R) mounted on the housing member for clockwise and counter-clockwise rotation; and,
   a torque shaft (76) connected to the rotor member (72R) and coupled to the surgical instrument clamp (92) for extending and retracting the surgical instrument clamp (92) in response to clockwise and counterclockwise rotation of the rotor member (72R).

6. Surgical instrument support apparatus (10) as claimed in any preceding claim, including a floor switch control circuit (64) coupled to the first and second rotary coupling apparatus (24,26) for selectively applying brake locking and brake releasing control signals.

7. Surgical instrument support apparatus (10) as claimed in claim 6, wherein the floor switch control circuit (64) is electrically coupled to the third rotary coupling apparatus (72,76,78) for controlling extension and retraction of the surgical instrument clamp (92) relative to the support arm assembly (20).

8. Surgical instrument support apparatus (10) as claimed in any preceding claim wherein the rail clamp (18) comprises;

   a clamp body (61) including a jaw member (69) projecting from the clamp body (61) for engaging a side rail (12) of an operating table (14), and including a cavity (63) for receiving a compression member (65);

a compression member (65) mounted within the clamp body cavity (63) for movement to an extended position in which the side rail (12) is clamped between the fixed jaw member (69) and the compression member (65), and to a retracted position in which the fixed jaw member (69) and the compression member (65) are released from clamping engagement with the said rail (12); and,
means (67) coupled to the compression member (65) for moving the compression member (65) from the released position to the clamped position.

9. Surgical instrument support apparatus (10) as claimed in any preceding claim, wherein:

the bearing member (58) includes a housing member (50) coupled to the rail clamp (18), and the rotary coupling shaft (34) is mounted for rotation within the housing member (50) on roller bearings (52,54); and,
the brake (59) includes a friction band (30,32) engagable with the rotary coupling shaft (34) for fixing the rotational position of the rotary coupling shaft (34) relative to the housing member (50) in response to an electrical control signal.

10. Surgical instrument support apparatus (10) as claimed in any preceding claim further including fastener means (22,20A,56) releasably coupled between the rotary coupling shaft (34) and the proximal support arm (20A) for enabling manual elevation adjustment of the support arm assembly (20) relative to the rail clamp (18).

Patentansprüche

1. Stützvorrichtung für ein chirurgisches Instrument (10), umfassend:

eine Schienenklemmvorrichtung (18), die zur lösbaren Befestigung an die Seitenschiene (12) eines Operationstisches (14) konfiguriert ist;

eine Stützarm-Anordnung (20), die an die Schienenklemmvorrichtung (18) montiert ist, wobei die Stützarm-Anordnung einen proximalen Stützarm (20A) einschließt, der beweglich mit der Schienenklemmvorrichtung zur Rotation um eine vertikale Achse verbunden ist, und einen distalen Stützarm (20B), der während eines chirurgischen Vorgangs zum Stützen eines chirurgischen Instruments (16) in einer festen Position über dem Operationstisch (14) dient;

eine Klemmvorrichtung (92), die an den distalen Stützarm (20B) zum lösbaren Halten eines chirurgischen Instruments (16) befestigt ist;

eine Positionsjustierungsvorrichtung, die mit dem distalen Stützarm (20B) und der Klemmvorrichtung des chirurgischen Instruments (92) verbunden ist, um die Klemmvorrichtung des chirurgischen Instruments (92) in der Höhe relativ zum Operationstisch (14) zu bewegen; dadurch gekennzeichnet, daß

eine erste rotierende Kupplungsvorrichtung (24), die ein Lagerelement (58) einschließt, mit der Schienenklemmvorrichtung (18) verbunden ist, eine rotierende Kupplungswelle (34) auf das Lagerelement (58) montiert und mit dem proximalen Stützarm (20A) verbunden ist, und eine Bremse (59) mit der rotierenden Kupplungswelle (34) lösbar verbunden ist, wobei die erste rotierende Kupplungsvorrichtung (24) auf ein oder mehrere elektrische Steuersignale reagiert, um die Bremse (59) selektiv in Eingriff zu bringen und die rotierende Kupplungswelle (34) in einer ersten festen Rotationshalteposition zu blockieren, und um die Bremse (59) selektiv außer Eingriff zu bringen und die rotierende Kupplungswelle (34) zu lösen, so daß der proximale Stützarm (20A) von einer ersten festen Rotationshalteposition zu einer zweiten festen Rotationshalteposition gedreht werden kann.

2. Stützvorrichtung für ein chirurgisches Instrument (10) nach Anspruch 1, wobei der proximale Stützarm (20A) durch eine senkrechte Stützwelle (22) verstellbar mit der rotierenden Kupplungswelle (34) zum Ausdehnen und Zurückziehen in der Höhe verbunden ist.

3. Stützvorrichtung für ein chirurgisches Instrument (10) nach einem der vorstehenden Ansprüche, wobei der proximale Stützarm (20A) und der distale Stützarm (20B) zur Winkelverschiebung relativ zueinander beweglich miteinander verbunden sind; und
wobei eine zweite rotierende Kupplungsvorrichtung (26) zwischen den proximalen Stützarm (20A) und den distalen Stützarm (20B) gekoppelt ist, wobei die zweite rotierende Kupplungsvorrichtung eine Bremsanordnung (28) einschließt und auf eines oder mehrere elektrische Steuersignale reagiert, um den proximalen Stützarm (20A) und den distalen Stützarm (20B) in einer festen Winkelverschiebung relativ zueinander selektiv zu blockieren und um die Bremse (28) selektiv zu lösen, so daß die Stützarme (20A, 20B) im Winkel relativ zueinander verschoben werden können.

4. Stützvorrichtung für ein chirurgisches Instrument (10) nach einem der vorstehenden Ansprüche, wobei die Positionsjustierungsvorrichtung umfaßt:
eine dritte rotierende Kupplungsvorrichtung (72, 76, 78), die zwischen dem distalen Stützarm (20B) und der Klemmvorrichtung des chirurgischen Instruments (92) gekoppelt ist, und zwar zum Ausdehnen und Zurückziehen der Klemmvorrichtung des chirurgischen Instruments (92) in der Höhe relativ zum Operationstisch (14).

5. Stützvorrichtung für ein chirurgisches Instrument nach Anspruch 4, wobei die dritte rotierende Kupplungsvorrichtung (72, 76, 78) umfaßt:

einen umkehrbaren Antriebsmotor (72), der ein Gehäuseelement (74) einschließt, das auf den distalen Stützarm (20B) montiert ist, sowie ein Rotorelement (72R), das zur Rotation im Uhrzeigersinn und gegen den Uhrzeigersinn auf dem Gehäuseelement montiert ist; und
eine Verdrehwelle (76), die mit dem Rotorelement (72R) verbunden ist und an die Klemmvorrichtung des chirurgischen Instruments (92) zum Ausdehnen und Zurückziehen der Klemmvorrichtung des chirurgischen Instruments (92) gekoppelt ist, und zwar in Abhängigkeit der Rotation des Rotorelements (72R) im Uhrzeigersinn und gegen den Uhrzeigersinn.

6. Stützvorrichtung für ein chirurgisches Instrument (10) nach einem der vorstehenden Ansprüche, das einen Bodenschaltungssteuerkreis (64) einschließt, der mit der ersten und zweiten rotierenden Kupplungsvorrichtung (24, 26) zur selektiven Anlegung der Steuersignale zum Blockieren der Bremse und zum Lösen der Bremse verbunden ist.

7. Stützvorrichtung für ein chirurgisches Instrument (10) nach Anspruch 6, wobei der Bodenschaltungssteuerkreis (64) mit der dritten rotierenden Kupplungsvorrichtung (72, 76, 78) elektrisch verbunden ist, um das Ausdehnen und Zurückziehen der Klemmvorrichtung des chirurgischen Instruments (92) relativ zur Stützarm-Anordnung (20) zu steuern.

8. Stützvorrichtung für ein chirurgisches Instrument (10) nach einem der vorstehenden Ansprüche, wobei die Schienenklemmvorrichtung (18) umfaßt:

einen Klemmkörper (61), der eine Klemmbacke (69) einschließt, die von dem Klemmkörper (61) vorspringt, um die Seitenschiene (12) des Operationstisches (14) in Eingriff zu nehmen, und der einen Hohlraum (63) zur Aufnahme eines Druckgliedes (65) einschließt;

ein Druckglied (65), das im Hohlraum des Klemmkörpers (63) für die Bewegung in eine ausgedehnte Position montiert ist, in der die Seitenschiene (12) zwischen die feste Klemmbacke (69) und das Druckglied (65) geklemmt ist, und zu einer zurückgezogenen Position, in der die feste Klemmbacke (69) und das Druckglied (65) von dem Klemmeingriff mit der Seitenschiene (12) gelöst sind; und

eine Einrichtung (67), die mit dem Druckglied (65) verbunden ist, um das Druckglied (65) von der gelösten Position in die geklemmte Position zu bewegen.

9. Stützvorrichtung für ein chirurgisches Instrument (10) nach einem der vorstehenden Ansprüche, wobei:

das Lagerelement (58) ein Gehäuseelement (50) einschließt, das mit der Schienenklemmvorrichtung (18) verbunden ist, und die rotierende Kupplungswelle (34) zur Rotation innerhalb des Gehäuseelements (50) auf Wälzlager (52, 54) montiert ist; und

die Bremse (59) ein Reibungsband (30, 32) einschließt, das mit der rotierenden Kupplungswelle (34) verbunden werden kann, um die Rotationsposition der rotierenden Kupplungswelle (34) relativ zum Gehäuseelement (50) in Abhängigkeit eines elektrischen Steuersignals zu fixieren.

10. Stützvorrichtung für ein chirurgisches Instrument (10) nach einem der vorstehenden Ansprüche, wobei diese weiter Befestigungseinrichtungen (22, 20A, 56) einschließt, die lösbar zwischen der rotierenden Kupplungswelle (34) und dem proximalen Stützarm (20A) befestigt sind, um die manuelle Höhenjustierung der Stützarmanordnung (20) relativ zur Schienenklemmvorrichtung (18) zu ermöglichen.

Revendications

1. Appareil de support d'instrument chirurgical (10) comprenant :

une pince de rail (18) conformée pour une fixation amovible sur le rail latéral (12) d'une table d'opération (14);
un ensemble de bras de support (20) monté sur la pince de rail (18), l'ensemble de bras de support comportant un bras de support proximal (20A), accouplé d'une manière mobile à la pince de rail pour une rotation autour d'un axe ver-

tical, et un bras de support distal (20B) servant à porter un instrument chirurgical (16) dans une position fixe surplombant la table d'opération (14) pendant une procédure chirurgicale ;
une pince (92) fixée au bras de support distal (20B) pour maintenir un instrument chirurgical (16) d'une manière amovible ;
un dispositif d'ajustement de position accouplé au bras de support distal (20B) et à la pince d'instrument chirurgical (92) pour déplacer la pince d'instrument chirurgical (92) en hauteur par rapport à la table d'opération (14) ;

caractérisé en ce que

un premier dispositif d'accouplement rotatif (24) comportant un élément d'appui (58) est accouplé à la pince de rail (18), un arbre d'accouplement rotatif (34) est monté sur l'élément d'appui (58) et accouplé au bras de support proximal (20A), et un frein (59) est accouplé d'une manière amovible à l'arbre d'accouplement rotatif (34), le premier dispositif d'accouplement rotatif (24) pouvant répondre à un ou plusieurs signaux électriques de commande pour mettre d'une manière sélective le frein (59) en prise et verrouiller l'arbre d'accouplement rotatif (34) dans une première position fixe de support en rotation et pour mettre d'une manière sélective le frein (59) hors de prise et libérer l'arbre d'accouplement rotatif (34) de façon que le bras de support proximal (20A) puisse faire l'objet d'une rotation, de la première position fixe de support en rotation à une seconde position fixe de support en rotation.

2. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans la revendication 1, dans lequel le bras de support proximal (20A) est accouplé d'une manière ajustable à l'arbre d'accouplement rotatif (34) pour un déploiement et une rétraction en hauteur au moyen d'un arbre de support vertical (22).

3. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans une revendication précédente quelconque, dans lequel le bras de support proximal (20A) et le bras de support distal (20B) sont accouplés ensemble d'une manière mobile pour un décalage angulaire l'un par rapport à l'autre et

un second dispositif d'accouplement rotatif (26) accouplé entre le bras de support proximal (20A) et le bras de support distal (20B), le second dispositif d'accouplement rotatif comprenant un ensemble de frein (28) et pouvant répondre à un ou plusieurs signaux électriques de commande pour verrouiller d'une manière sélective le bras de support proximal (20A) et le bras de support distal (20B) suivant un décalage angulaire fixe l'un par rapport à l'autre et pour libérer d'une manière sélective le frein (28) de façon que les bras de support (20A, 20B) puissent être décalés angulairement l'un par rapport à l'autre.

4. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans une revendication précédente quelconque, dans lequel le dispositif d'ajustement de position comprend :

un troisième dispositif d'accouplement rotatif (72, 76, 78) accouplé entre le bras de support distal (20B) et la pince d'instrument chirurgical (92) pour déployer et rétracter la pince d'instrument chirurgical (92) en hauteur par rapport à la table d'opération (14).

5. Appareil de support d'instrument chirurgical tel que revendiqué dans la revendication 4, dans lequel le troisième dispositif d'accouplement rotatif (72, 76, 78) comprend :

un moteur d'entraînement réversible (72) comportant un élément formant boîtier (74), monté sur le bras de support distal (20B), et un élément formant rotor (72R) monté sur l'élément formant boîtier pour une rotation dans le sens des aiguilles d'une montre et dans le sens contraire aux aiguilles d'une montre ; et
un arbre de couple (76) fixé à l'élément formant rotor (72R) et accouplé à la pince d'instrument chirurgical (92) pour déployer et rétracter la pince d'instrument chirurgical (92) en réponse à une rotation dans le sens des aiguilles d'une montre et à une rotation dans le sens contraire aux aiguilles d'une montre de l'élément formant rotor (72R).

6. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans une revendication précédente quelconque, comprenant un circuit de commande d'interrupteur de plancher (64) accouplé aux premier et second dispositifs d'accouplement rotatif (24, 26) pour appliquer d'une manière sélective des signaux de commande de verrouillage de frein et de libération de frein.

7. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans la revendication 6, dans lequel le circuit de commande d'interrupteur de plancher (64) est accouplé électriquement au troisième dispositif d'accouplement rotatif (72, 76, 78) pour commander un déploiement et une rétraction de la pince d'instrument chirurgical (92) par rapport à l'ensemble de bras de support (20).

8. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans une revendication précédente quelconque, dans lequel la pince de rail (18) comprend :

un corps de pince (61) comportant un élément formant mâchoire (69), faisant saillie à partir du corps de pince (61) pour venir en prise sur un rail latéral (12) d'une table d'opération (14), et comportant une cavité (63) pour recevoir un élément de compression (65) ;
un élément de compression (65) monté dans la cavité de corps de pince (63) pour un déplacement à une position déployée, dans laquelle le rail latéral (12) est serré entre l'élément formant mâchoire (69) fixe et l'élément de compression (65), et à une position rétractée dans laquelle l'élément formant mâchoire (69) fixe et l'élément de compression (65) sont libérés d'une venue en prise de serrage avec ledit rail (12) ; et
des moyens (67) accouplés à l'élément de compression (65) pour déplacer l'élément de compression (65) de la position libérée à la position serrée.

9. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans une revendication précédente quelconque, dans lequel :

l'élément d'appui (58) comprend un élément formant boîtier (50) accouplé à la pince de rail (18), et l'arbre d'accouplement rotatif (34) est monté pour une rotation dans l'élément formant boîtier (50) sur des roulements (52, 54) ; et
le frein (59) comprend une bande de frottement (30, 32) pouvant venir en prise avec l'arbre d'accouplement rotatif (34) pour fixer la position en rotation de l'arbre d'accouplement rotatif (34) par rapport à l'élément formant boîtier (50) en réponse à un signal électrique de commande.

10. Appareil de support d'instrument chirurgical (10) tel que revendiqué dans une revendication précédente quelconque, comprenant en outre des moyens de fixation (22, 20A, 56) accouplés d'une manière amovible entre l'arbre d'accouplement rotatif (34) et le bras de support proximal (20A) pour permettre un ajustement manuel en hauteur de l'ensemble de bras de support (20) par rapport à la pince de rail (18).

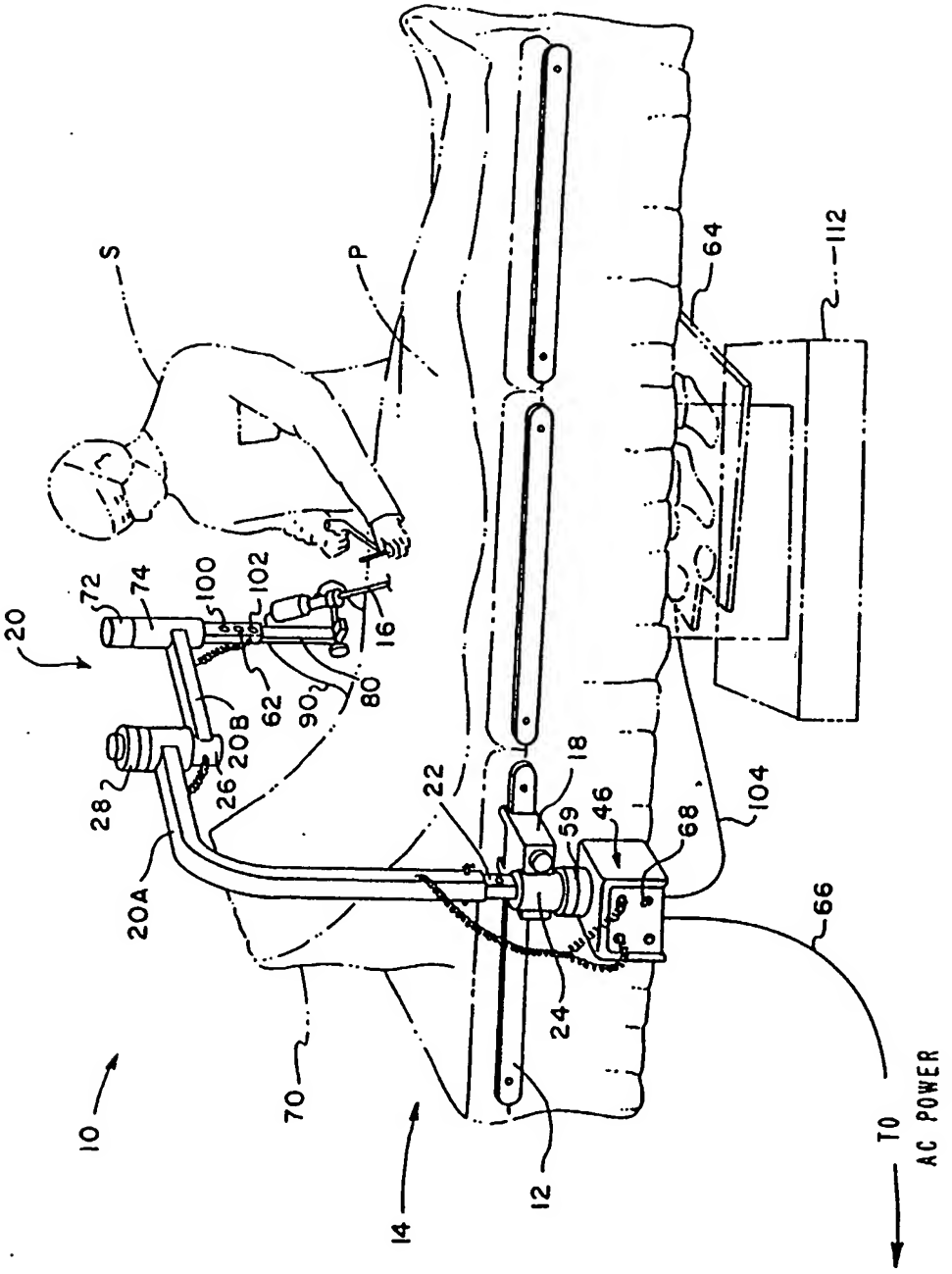
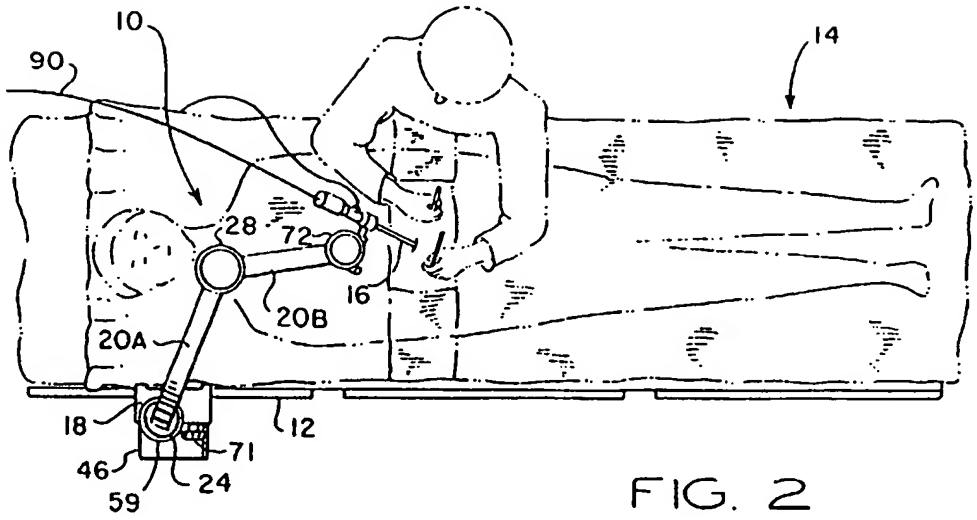

S
P
64
112
72
74
100
102
16
20
62
90
80
208
28
26
22
18
59
46
68
104
20A
66
24
70
10
14
12
TO
AC POWER

FIG. 1


10
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14
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72
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20B
20A
18
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71
46
24
59

FIG. 2

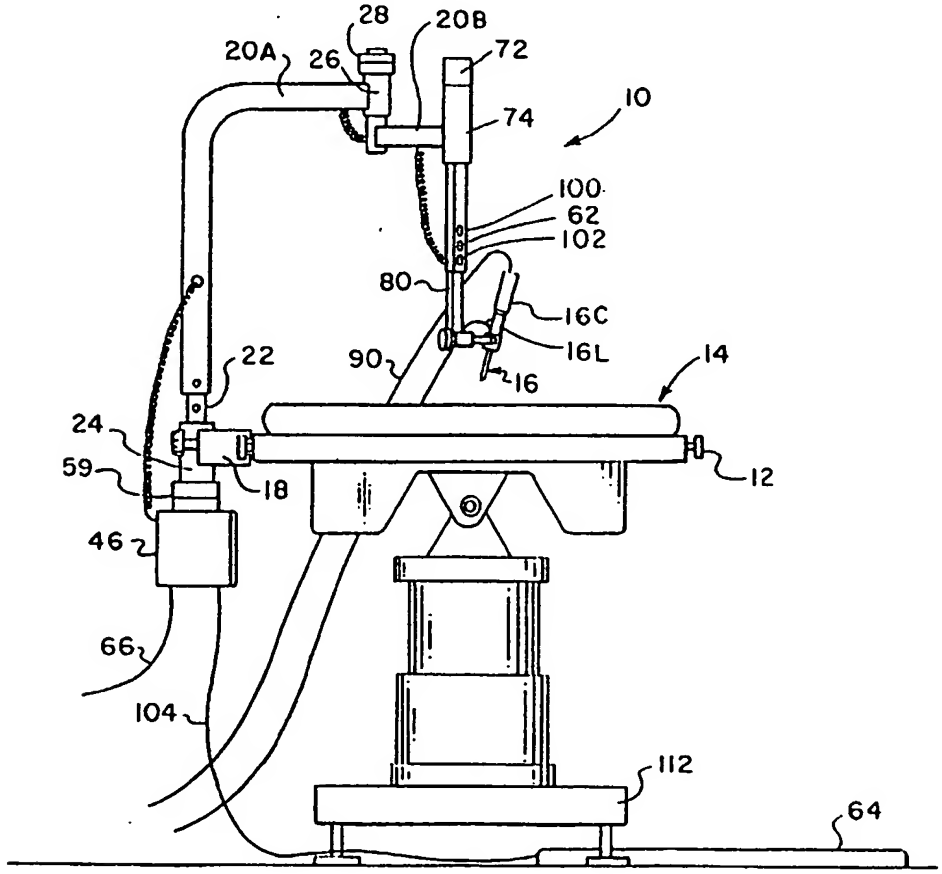

28
20B
20A
26
72
74
10
100
62
102
80
16C
16L
90
16
14
22
24
59
18
12
46
66
104
112
64

FIG. 3

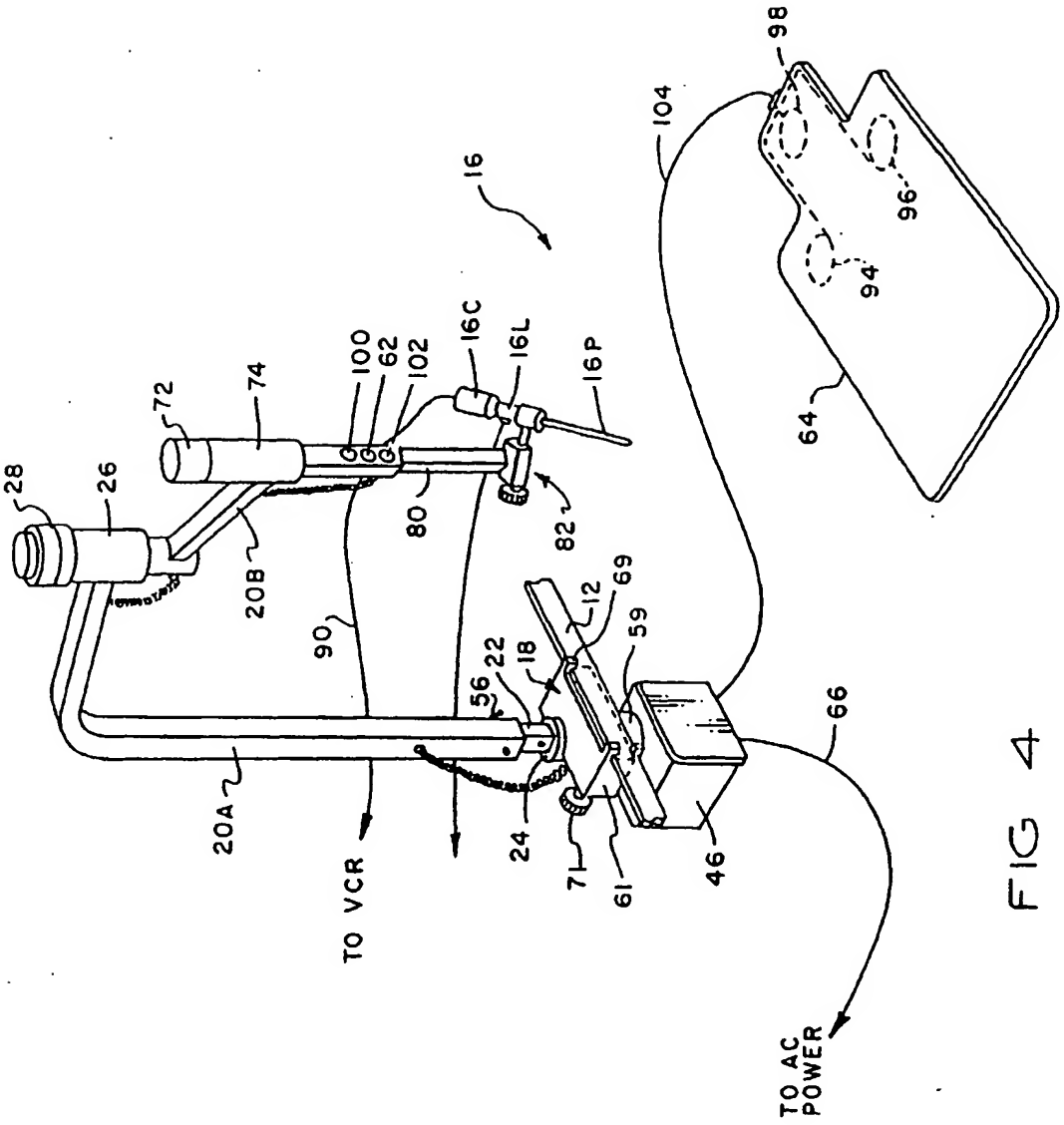

16
16C
16L
16P
100
62
102
72
74
28
26
20B
80
82
90
12
69
59
22
18
56
20A
24
71
61
46
66
TO VCR
TO AC POWER
98
104
96
94
64

FIG 4

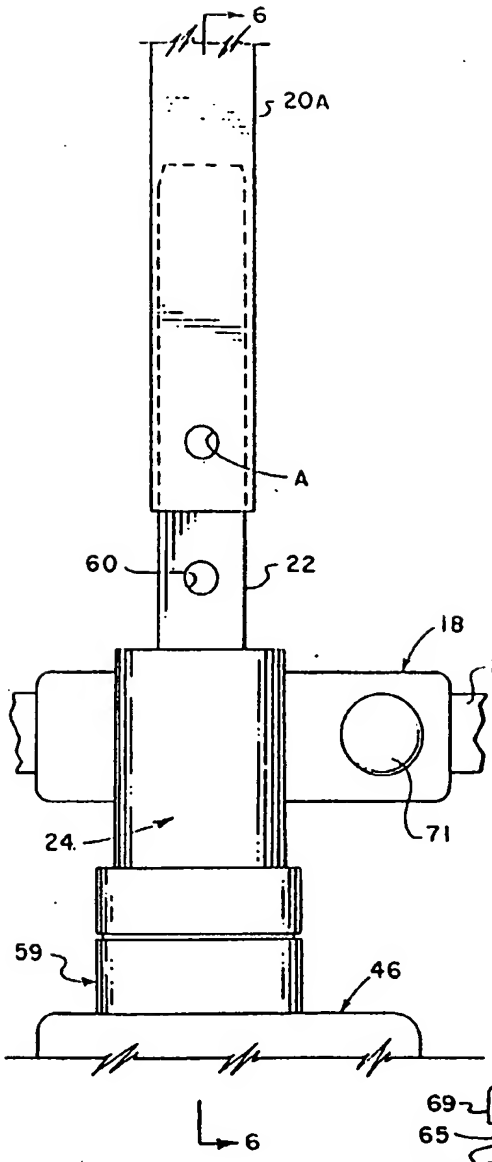

6
20A
A
60
22
18
12
71
24
59
46
6

FIG. 5

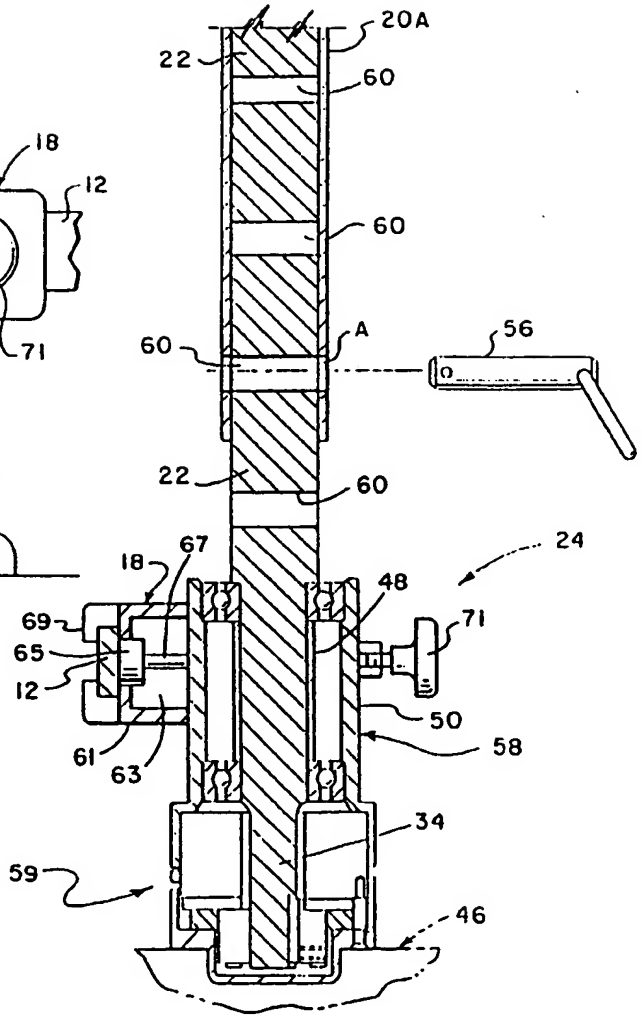

20A
22
60
60
A
56
60
22
60
24
18
67
48
69
71
65
12
50
58
61
63
34
59
46

FIG. 6

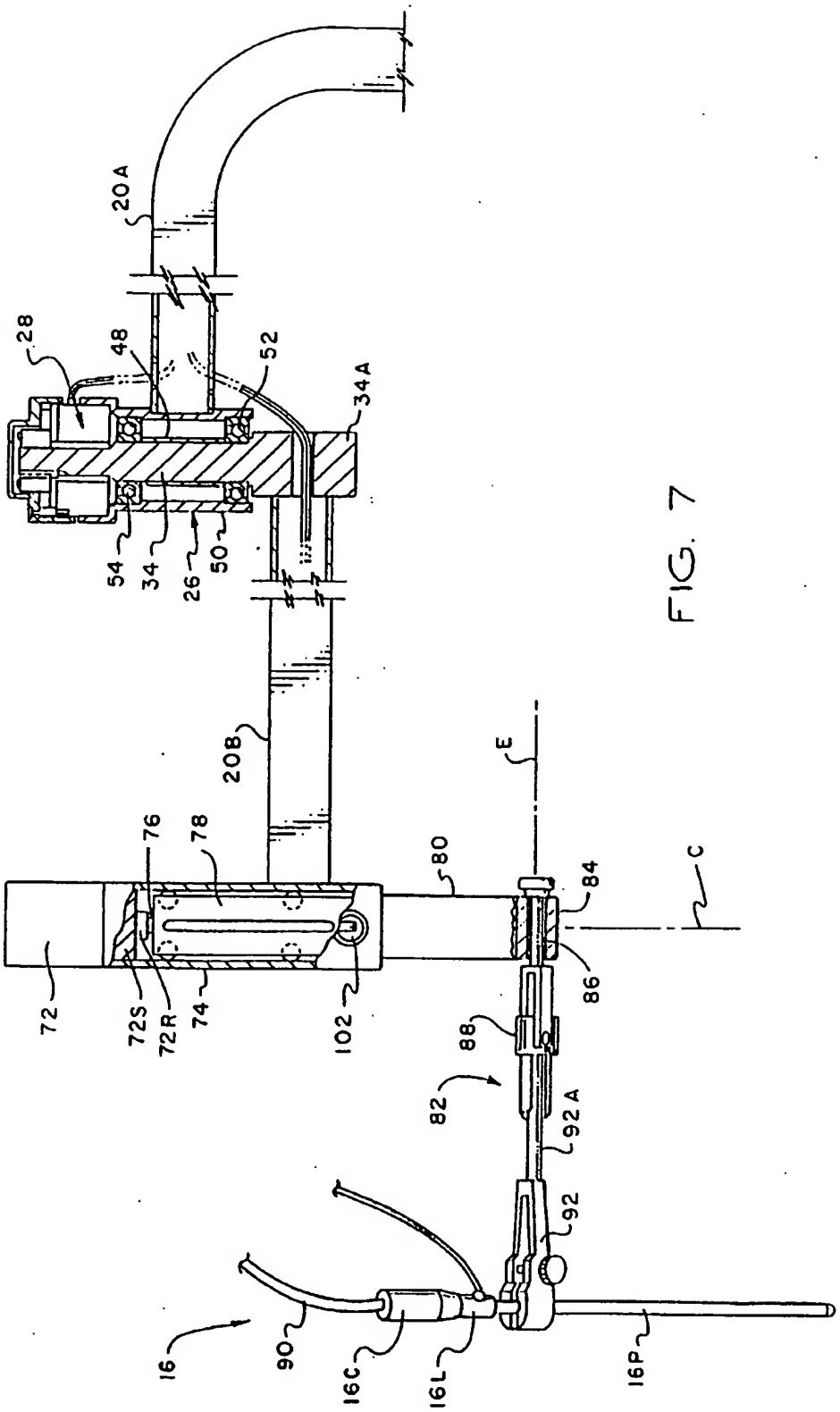

20A
28
48
52
34A
54
34
26
50
208
E
76
78
80
84
C
72
72S
72R
74
102
86
88
82
92A
92
16
90
16C
16L
16P

FIG. 7

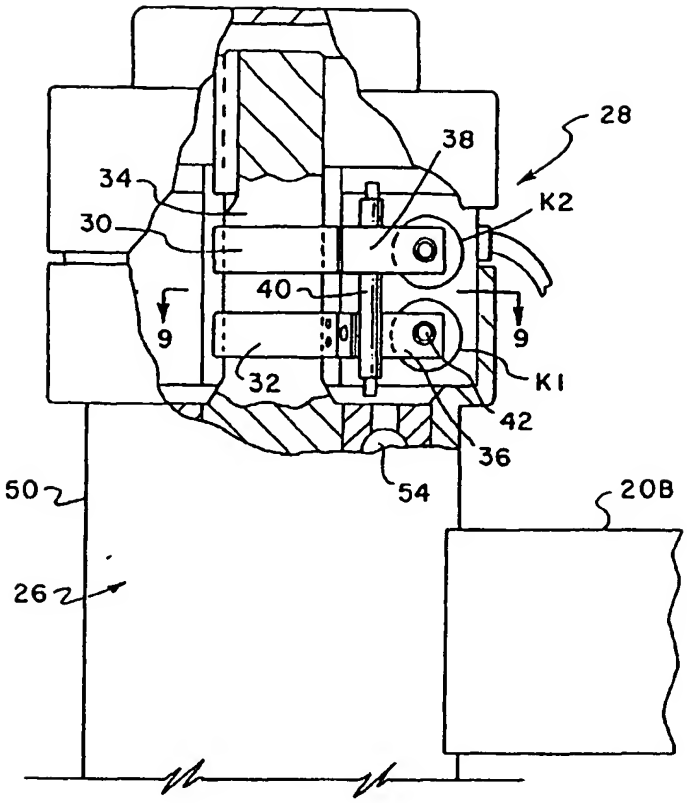
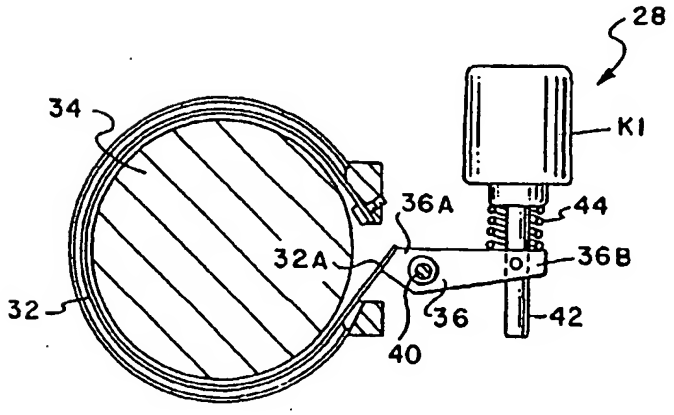

28
38
34
K2
30
40
9
9
32
K1
42
36
54
50
20B
26

FIG. 8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34
K1
36A
44
32A
36B
32
36
42
40

FIG. 9

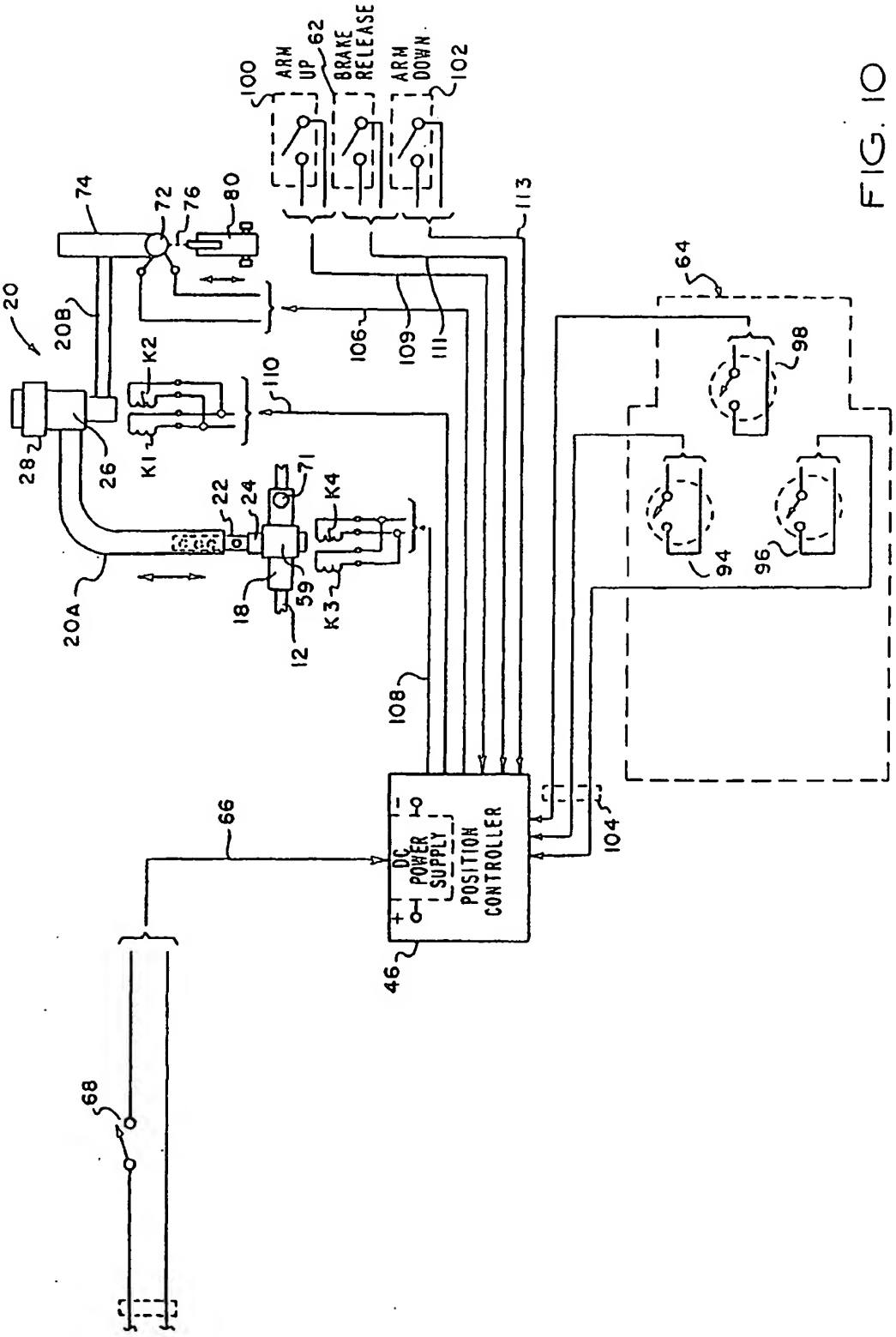
ARM UP
62
BRAKE RELEASE
ARM DOWN
102
100
74
72
76
80
113
64
20
208
K2
110
106
109
111
98
28
26
K1
22
24
71
K4
94
96
20A
18
59
K3
12
108
66
DC POWER SUPPLY
POSITION CONTROLLER
104
46
68

FIG. 10